REMARKS

Applicants respectfully request reconsideration of the application, as amended, in view of the following remarks.

The present invention as set forth in **amended Claim 1** relates to a water-soluble polymer composition obtained by continuous polymerization of at least one unsaturated monomer, wherein during said polymerization at least one parameter biasing the polymerization is varied according to **a recurrent pattern**.

The term "recurrent pattern" is defined at page 4 of the specification, 2nd paragraph:

> In the meaning of the invention, "according to a recurrent pattern" means that the parameters biasing the polymerization are varied in any desired manner, but at regular recurring time intervals within a reasonable range familiar to those skilled in the art, and preferably in a continuous fashion.

EP 0 630 909 A1 or Patel et al (US 6,103,839) fail to disclose or suggest a water-soluble polymer composition obtained by continuous polymerization of at least one unsaturated monomer, wherein during said polymerization at least one parameter biasing the polymerization is varied according to **a recurrent pattern**.

EP 0 630 909 A1 merely discloses feeding monomer in increments, but there is no **recurrent pattern** in which parameters biasing the polymerization are **varied at regular recurring time intervals**.

Patel et al (US 6,103,839) fail to disclose or suggest a **recurrent pattern** in which parameters biasing the polymerization are **varied at regular recurring time intervals**.

In addition, **new Claim 19** has been added which relates to a water-soluble polymer composition, obtained by continuous polymerization of at least one unsaturated monomer; wherein during said polymerization at least one parameter biasing the polymerization is varied according to a recurrent pattern;

wherein said **recurrent pattern is an oscillation** about a mean value which can be selected at random;

wherein at least one of the following parameters is subject to variation:

- a concentration of at least one monomer,
- an amount of a catalyst,
- an amount of a molecular weight modifier,
- a pH value of a monomer solution, or
- a composition of said monomer solution.

In contrast, EP 0 630 909 A1 and Patel et al (US 6,103,839) fail to disclose or suggest a water-soluble polymer composition, obtained by continuous polymerization of at least one unsaturated monomer; wherein during said polymerization at least one parameter biasing the polymerization is varied according to a recurrent pattern which **is an oscillation** about a mean value which can be selected at random.

Specifically, EP 0 630 909 A1 and Patel et al do not disclose or suggest that a parameter **oscillates** about a mean value during the polymerization. In other words there are no recurring minima and maxima of a parameter such as

- a concentration of at least one monomer,
- an amount of a catalyst,
- an amount of a molecular weight modifier,
- a pH value of a monomer solution, or
- a composition of said monomer solution.

Therefore, the rejection of Claims 1-7, and 9-17 under 35 U.S.C. § 102(b) and 102(e) as anticipated by or, in the alternative, under 35 U.S.C. §103 (a) as obvious over EP 0 630 909 A1 or Patel et al (US 6,103,839) is believed to be unsustainable as the present invention is neither anticipated nor obvious and withdrawal of this rejection is respectfully requested.

The rejection of Claims 1-7 and 9-17 under 35 U.S.C. § 112, 2nd paragraph, is in part obviated by the amendment of Claim 1.

The rejection of Claims 1-7 and 9-17 under 35 U.S.C. § 112, 2nd paragraph, is traversed with respect to the term "recurrent pattern" and "harmonic," "anharmonic" and "undamped" oscillation.

The term "recurrent pattern" is defined at page 4 of the specification, 2nd paragraph:

> In the meaning of the invention, "according to a recurrent pattern" means that the parameters biasing the polymerization are varied in any desired manner, but at regular recurring time intervals within a reasonable range familiar to those skilled in the art, and preferably in a continuous fashion.

Further, the above terms pertaining to oscillation are well known terms of art, the definition of which can be obtained from text books in mathematics or physics. As an example, Applicants attach herewith documents retrieved from the website of the Department of Physics of the University of Munich as well as an English translation of these documents. A **harmonic oscillation** is defined as a sinusoidal oscillation (see page 1 of the English translation).

Another example has been retrieved from the website of 2dcurves.com. Harmonic oscillation is defined and depicted as a sinus function. A **damped harmonic oscillation** is defined by a decrease in amplitude over time. Different types of damping are shown. On the other hand, if an oscillation is **undamped**, no decrease in amplitude occurs over time.

An **anharmonic oscillation** is characterized by a non-linear change in amplitude, frequency or both. For example, random noise is an anharmonic oscillation as shown in the document retrieved from the website of sfu.ca/sonic-studio/handbook. Thus, the above terms are not indefinite and Claims 1-7 recite all pertinent features. Accordingly, this rejection is unsustainable and should be withdrawn.

This application presents allowable subject matter, and the Examiner is kindly requested to pass it to issue. Should the Examiner have any questions regarding the claims or otherwise wish to discuss this case, he is kindly invited to contact Applicants' below-signed representative, who would be happy to provide any assistance deemed necessary in speeding this application to allowance.

Respectfully submitted,

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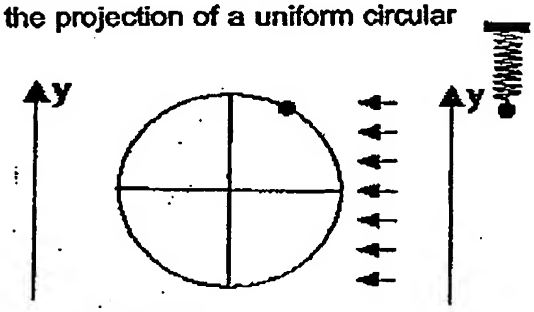
Basic knowledge

Harmonic oscillation

Definition

Oscillations are processes in which a physical state varies periodically with time.

The most important type of oscillation is ***harmonic oscillation*** or the type of ***sinusoidal oscillation***. It occurs, for example, in the projection of a uniform circular motion, or in the oscillation of a spring pendulum.

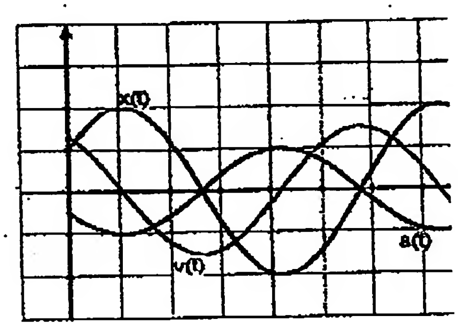


These two types are illustrated once again in the small animation.

Note:

It is usual to describe a harmonic oscillation starting with a phase angle of $\phi = 0°$. If, for example, the body is already at an angle other than zero at time t=0, this must be taken into account in the description.

Equations of motion



Position as a function of time:
$x(t) = \hat{x} \cdot \sin(\omega \cdot t + \phi)$

Velocity as a function of time:
$v(t) = \hat{x} \cdot \omega \cdot \cos(\omega \cdot t + \phi) = \hat{v} \cdot \cos(\omega \cdot t + \phi)$

Acceleration as a function of time:
$a(t) = -\hat{x} \cdot \omega^2 \cdot \sin(\omega \cdot t + \phi) = -\hat{a} \cdot \sin(\omega \cdot t + \phi)$

Designations		***Relationships***
x(t): Elongation	T: Period of oscillation	$T=\frac{1}{f}$ $\omega=2\pi f=\frac{2\pi}{T}$
x: Amplitude	f: Frequency of oscillation	

ω: circular frequency ϕ: phase angle

Linear force law

A harmonic oscillation comes about if there is a linear force law F~x in the oscillating system.
Conversely, the presence of a harmonic oscillation indicates a linear force law.

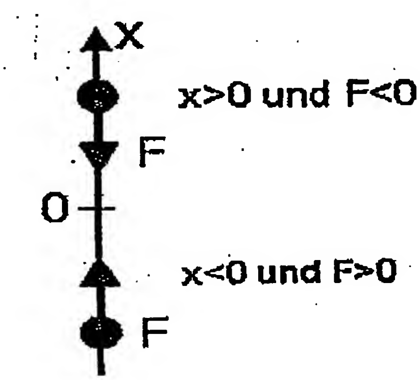
harmonic oscillation $\rightleftarrows$ linear force law

Restoring force - Directional variable - Period of oscillation

The following results from applying Newton's second law (F=m·a) to the above relationship between time and acceleration, and from taking into account the relationship between time and position:

$$F(t) = -m \cdot \omega^2 \cdot x(t)$$

- The proportionality between the force and the deflection (linear force law) can be read off from this relationship. The constant of proportionality $C = m \cdot \omega^2$ is denoted as ***directional variable***.
- It may also be seen from this relationship that the force always has the opposite sign to that of the deflection. If, for example, x is positive, the force is negative, that is to say it points in the negative x-direction. The force is therefore always directed towards the zero point of the oscillation. Consequently, it is denoted as a ***restoring force***.



- ***Period of oscillation of the spring pendulum***
  The directional variable C is equal to the spring temper D (Hooke's law) in the case of a spring pendulum, and so it holds that:

$$D=m\cdot\omega^2 \rightarrow D=m\cdot\left(\frac{2\cdot\pi}{T}\right)\Rightarrow T=2\cdot\pi\sqrt{\frac{m}{D}}$$

The period of oscillation of the spring pendulum is independent of the deflection of the pendulum.

- ***Period of oscillation of the thread pendulum***

$$T=2\cdot\pi\sqrt{\frac{1}{g}}$$

This formula holds only for small pendulum deflections. With this restriction, T is independent of the deflection (if only it is small enough), and also independent of the pendulum mass. The quantity g is the local factor.

Energy considerations in relation to oscillation

A periodic to-ing and fro-ing between the two forms of energy "kinetic energy" and "potential energy", is to be observed in the mechanic oscillation. For the spring pendulum, in particular, it holds that:

$$\mathbf{E_{ges}=E_{pot}+E_{kin}} \quad \Rightarrow \quad \mathbf{E_{ges}=\frac{1}{2}\cdot m\cdot v(t)^2+\frac{1}{2}\cdot D\cdot x(t)^2}$$

$$\mathbf{E_{ges}=\frac{1}{2}\cdot m\cdot[\hat{x}\cdot\omega\cdot\cos(\omega\cdot t+\varphi)]^2+\frac{1}{2}\cdot D\cdot[\hat{x}\cdot\sin(\omega\cdot t+\varphi)]^2}$$

$$\mathbf{mit\quad D=m\cdot\omega^2\ ergibt\ sich:}$$

$$\mathbf{E_{ges}=\frac{1}{2}\cdot m\cdot\hat{x}^2\cdot\omega^2=const\ da\left[\cos(\omega\cdot t+\varphi)\right]^2+\left[\sin(\omega\cdot t+\varphi)\right]^2=1\,ist.}$$

The total energy of the oscillation is therefore constant with time.

Note:

The periodic to-ing and fro-ing between two forms of energy is a general characteristic of an oscillation. Thus, in the case of electromagnetic oscillations there is a to-ing and fro-ing between "electric energy" and "magnetic energy".

The fundamentals of the harmonic oscillation of a spring pendulum are very impressively summarized in the **Applet** of W. Fendt.

Back to material page

Comparison between mechanical and electromagnetic oscillations

Free undamped oscillation:

Mechanical spring oscillation	Undamped resonant circuit
External force = 0	External force = 0
Frictional force = 0	Ohmic resistance = 0
$F = F_{inertia} + F_{spring} = 0$	$U = U_L + U_C = 0$
$ma + Dx = 0$	$LI + \frac{1}{C}Q = 0$
$mx + Dx = 0$	$LQ + \frac{1}{C}Q = 0$
$x + \frac{D}{m}x = 0$	$Q + \frac{1}{LC}Q = 0$
$\omega = \sqrt{\frac{D}{m}}$ *with* *resulting* $x + \omega^2 x = 0$	$\omega = \frac{1}{\sqrt{LC}}$ *with* *resulting* $Q + \omega^2 Q = 0$
$x(t) = x_0 \cdot \cos \omega t$	$Q(t) = Q_0 \cdot \cos \omega t$

Free undamped oscillation:

Mechanical spring oscillation	Damped resonant circuit
External force = 0	External force = 0
Frictional force $F_R = k \cdot v \neq 0$	Ohmic resistance $R \neq 0$
$F = F_{inertia} + F_R + F_{spring} = 0$	$U = U_L + U_R + U_C = 0$
$ma + kv + Dx = 0$	$L\dot{I} + RI + \frac{1}{C}Q = 0$
$m\ddot{x} + k\dot{x} + Dx = 0$	$L\ddot{Q} + R\dot{Q} + \frac{1}{C}Q = 0$
Oscillation : $\frac{k^2}{4m^2} < \frac{D}{m}$	*Oscillation* : $\frac{R^2}{4L^2} < \frac{1}{LC}$
$x(t) = x_0 \cdot e^{-\frac{k}{2m}t} \cdot \cos \omega t$ *with* $\omega = \sqrt{\frac{D}{m} - \frac{k^2}{4m^2}}$	$Q(t) = Q_0 \cdot e^{-\frac{R}{2L}t} \cdot \cos \omega t$ *with* $\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$
aperiodic $\lim it : \frac{k^2}{4m^2} = \frac{D}{m}$	*aperiodic* $\lim it : \frac{R^2}{4L^2} = \frac{1}{LC}$

$x(t) = x_0 \cdot e^{-\frac{k}{2m}t}$	$Q(t) = Q_0 \cdot e^{-\frac{R}{2L}t}$
$Kriechfall: \frac{k^2}{4m^2} > \frac{D}{m}$	$Kriechfall: \frac{R^2}{4L^2} > \frac{1}{LC}$

SLk Ph 12 - Subject: Physics - List Subjects

Mathematik - Online - Lexikon: Explanation of

Superposition of harmonic oscillations of equal frequency

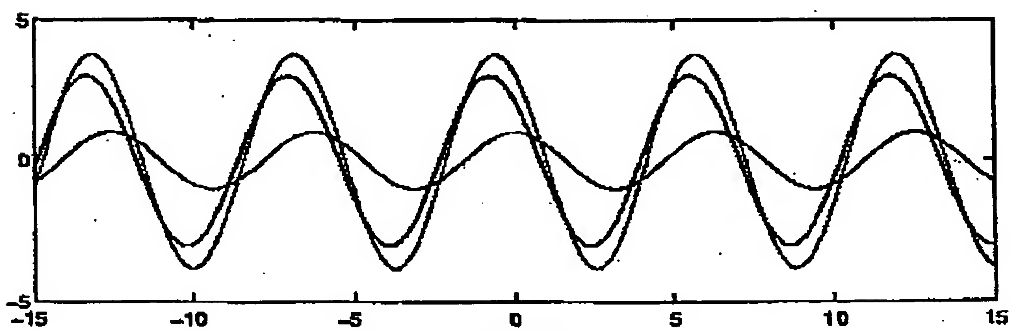
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Overview

The superposition of two harmonic oscillations

$$c_k \cos(\omega t - \delta_k), \quad k = 1,2,$$

is harmonic with an amplitude of

$$c = \sqrt{c_1^2 + 2\cos(\delta_1 - \delta_2)c_1 c_2 + c_2^2}\,.$$



$\cos t + 3\cos(t + \frac{\pi}{4})$

It follows from the complex form of superposition

$$\mathrm{Re}(c_1 \exp(i\omega t - \delta_1) + c_2 \exp(i\omega t - \delta_2)) = \mathrm{Re}([c_1 e^{-i\delta_1} + c_2 e^{-i\delta_2}]e^{i\omega t})$$

that

$$[\ldots] = c\exp(-i\delta) = z$$

and therefore that

$$c^2 = z\bar{z} = (c_1 e^{-i\delta_1} + c_2 e^{-i\delta_2})\,(c_1 e^{-i\delta_1} + c_2 e^{-i\delta_2}).$$

The assertion results from multiplying out taking account of $e^{is} + e^{-is} = 2 \cos s$.

Alternatively, the amplitude can be calculated from the representation

$$I_k(t) = a_k \cos(\omega t) + b_k \sin(\omega t).$$

This then yields

$$c = \sqrt{(a_1 + a_2)^2 + (b_1 + b_2)^2}\,.$$

(Authors: Höllig/Kopf)

Mathematik-Online-Lexikon: Explanation of

Modulated oscillation

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Overview

The superposition of two oscillations $c_k e^{i\omega k t}$ may be written as the product

$$c(t) = c_1 e^{-i\Delta\omega t} + c_2 e^{-i\Delta\omega t},$$

with $\bar{\omega} = (\omega_1 + \omega_2)/2$ and $\Delta\omega$ where $\Delta\omega = (\omega_1 - \omega_2)/2$. This resultant oscillation is periodic only if the frequency ratio ω_1/ω_2 is rational.

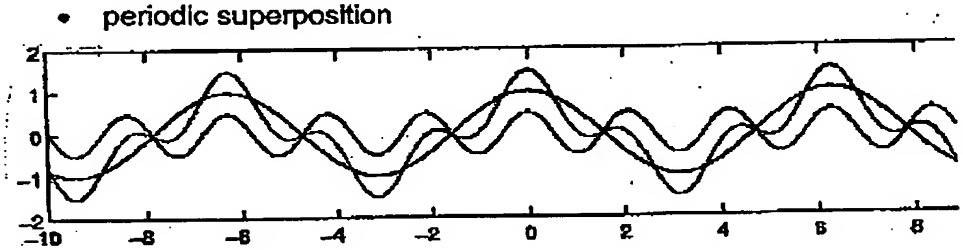
The modulus of the modulated complex amplitude fluctuates between the minimum and maximum values of $|c_1 - c_2|$ and $c_1 + c_2$. In particular,

$$c(t) = 2c\cos(\Delta\omega t)$$

for equal amplitudes $c = c_1 = c_2$.

The following illustrations show some typical cases.

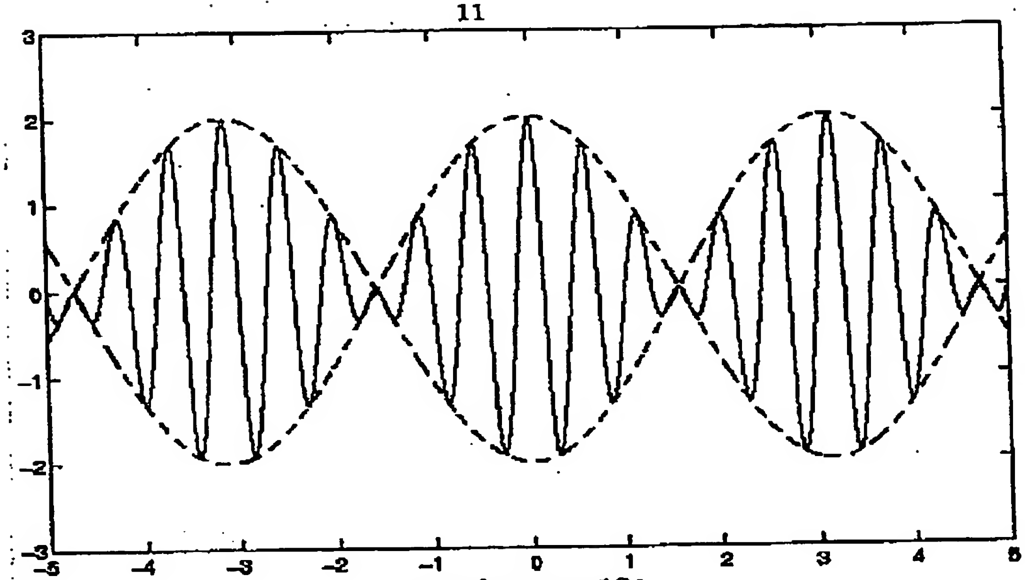
- periodic superposition



heightheight

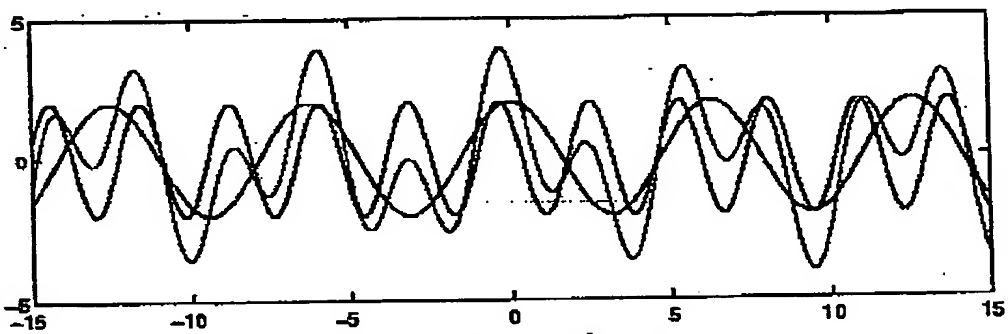
cos t + ½ cos 3t

- equal amplitudes and $\omega_1 \approx \omega_2$



$\cos 10t + \cos 12t$

- aperiodic superposition



$2\cos t + 2\cos(\sqrt{5}t + \frac{\pi}{4})$

(Authors: Höllig/Kopf)

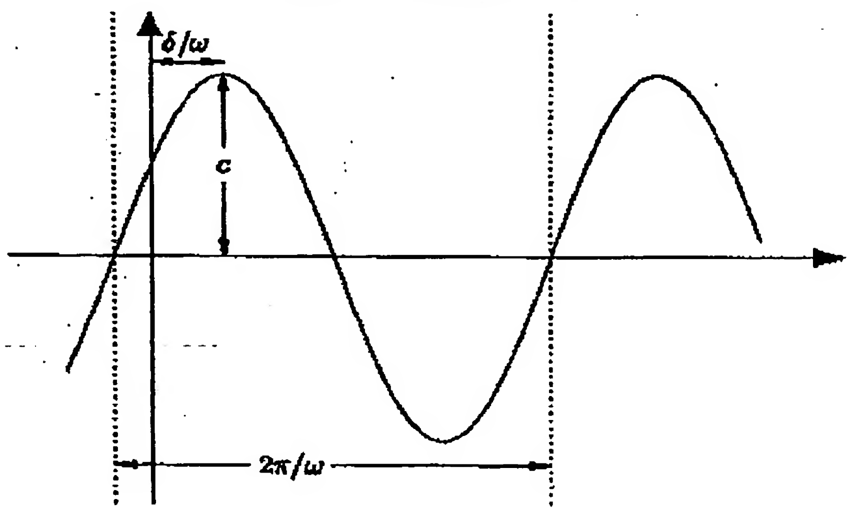
Mathematik - Online - Lexikon: Explanation of

Harmonic oscillation

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Overview

A harmonic oscillation of amplitude $c \neq 0$, frequency ω and phase shift δ has the form

$$x(t) = c\cos(\omega t - \delta)\ .$$



Equivalent representations are

$$\operatorname{Re} c \exp(i(\omega t - \delta))$$

or

$$a \cos(\omega t) + b \sin(\omega t)\ .$$

(Authors: Höllig/Kopf)

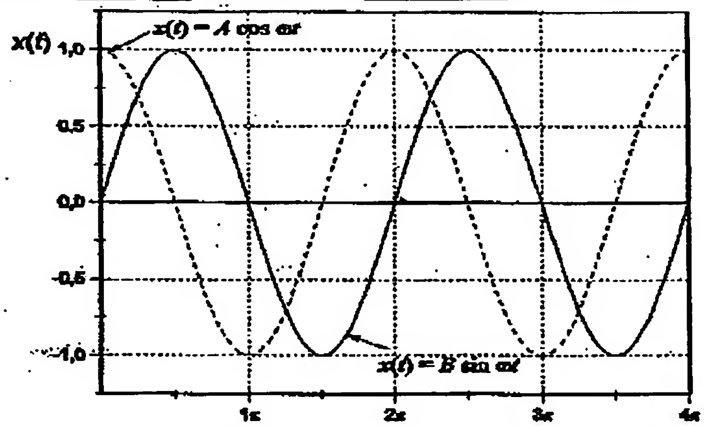
Explanation:

- Conversion of the parameters

If the state variable $x(t)$ of a periodic process changes in the form of a cosine or sine according to the law

$x(t) = A \cos \omega t$ or $x(t) = B \sin \omega t$

this is a harmonic oscillation. The figure below shows the plot of the two functions of the harmonic oscillation without damping with the two amplitudes A = 1 and B = 1.



Here, ω [1/s] is the angular frequency, given by

$$\omega = 2\pi f = \frac{2\pi}{T}$$

T[s] being the period, and f [Hz] being the frequency of the harmonic oscillation.
In general, pure sinusoidal and cosinusoidal oscillations can be written as superposition by means of a joint function

$$x(t)=A \cos \omega t + B \sin \omega t$$

By selecting a joint amplitude C, it is possible to transform this equation into the following form

$$x(t) = C \cos (\omega t-\phi_0)\,,$$

the amplitude C with the following individual amplitudes

$$A = C \cos \phi_0,$$

$$B = C \sin \phi_o,$$

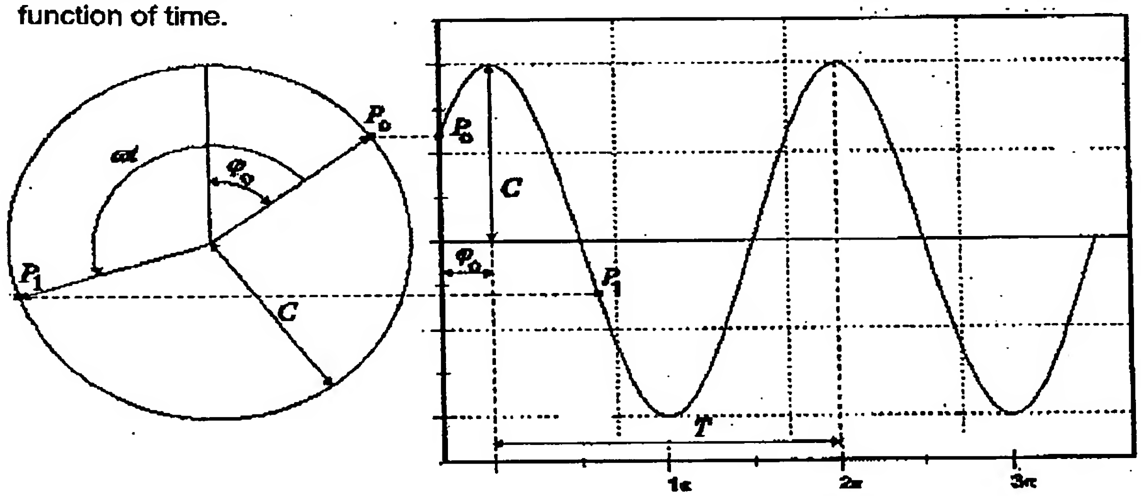
being given as follows

$$C = \sqrt{A^2 + B^2}\,.$$

Arbitrary initial conditions of the harmonic oscillation can be described using the phase shift ϕ_0 [rad], which is determined as follows

$$\phi_0 = \tan \frac{B}{A}.$$

The figure below shows that the harmonic oscillation projects the movement of a point on a circular path at constant angular frequency or angular velocity ω. The projection of the point P_o onto the vertical axis exhibits the harmonic oscillation as a function of time.



If the initial conditions of the harmonic oscillation are given by the initial deflection x_0 and the initial velocity v_o, namely

$$x(0) = x_0 \qquad \text{and} \qquad \dot{x}(0) = v_0$$

the constants *A*, *B*, *C* and the phase shift ϕ_0 can be determined as follows

$$x(0) = A = x_o,$$

$$\dot{x}(0) = B\omega = v_o \rightarrow B = \frac{v_0}{\omega},$$

$$C = \sqrt{x_0^{\,2} + \frac{v_0}{\omega}^{2}},$$

$$\phi_0 = \arctan \frac{v_0}{\omega x_0}.$$

►►► Oscillation, free oscillation, damped oscillation - **Home**

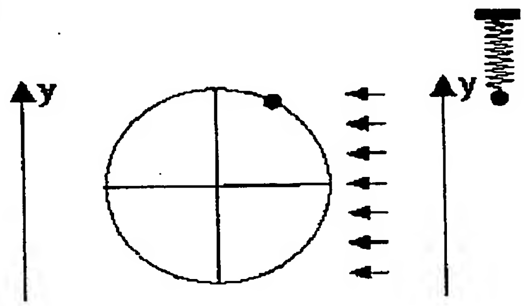
Grundwissen	*Harmonische Schwingung*	

Definition

Schwingungen sind Vorgänge, bei denen sich ein physikalischer Zustand zeitlich periodisch verändert.

Der wichtigste Schwingungstyp ist die ***harmonische Schwingung*** oder ***Sinusschwingung***. Er tritt z. B. bei der Projektion einer gleichförmigen Kreisbewegung oder bei der Schwingung eines Federpendels auf.

In der kleinen Animation werden diese beiden Typen nochmals dargestellt.



Hinweis:
Meist beschreibt man eine harmonische Schwingung, die beim Phasenwinkel $\varphi = 0°$ startet. Liegt z.B. der Körper zur Zeit $t = 0$ schon bei einem Winkel ungleich Null, so muss man dies bei der Beschreibung berücksichtigen.

Bewegungsgleichungen

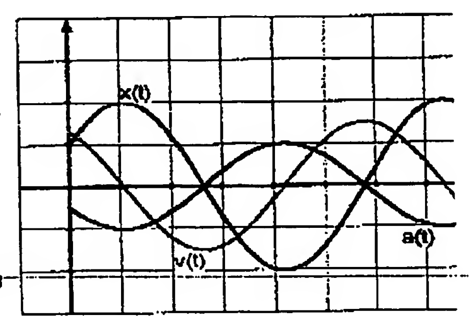
Zeit-Orts-Gesetz:

$$x(t) = \hat{x} \cdot \sin(\omega \cdot t + \varphi)$$

Zeit-Geschwindigkeits-Gesetz:

$$v(t) = \hat{x} \cdot \omega \cdot \cos(\omega \cdot t + \varphi) = \hat{v} \cdot \cos(\omega \cdot t + \varphi)$$

Zeit-Beschleunigungs-Gesetz: $a(t) = -\hat{x} \cdot \omega^2 \cdot \sin(\omega \cdot t + \varphi) = -\hat{a} \cdot \sin(\omega \cdot t + \varphi)$



Bezeichnungen

$x(t)$: Elongation

$\hat{x}$: Amplitude

T: Schwingungsdauer

f: Schwingungsfrequenz

Beziehungen

$$T = \frac{1}{f} \quad \omega = 2 \cdot \pi \cdot f = \frac{2 \cdot \pi}{T}$$

ω : Kreisfrequenz φ : Phasenwinkel

Lineares Kraftgesetz

Liegt bei dem schwingungsfähigen System ein lineares Kraftgesetz $F \sim x$ vor so kommt es zu einer harmonischen Schwingung.
Umgekehrt kann man aus dem Vorliegen einer harmonischen Schwingung auf ein lineares Kraftgesetz schließen.

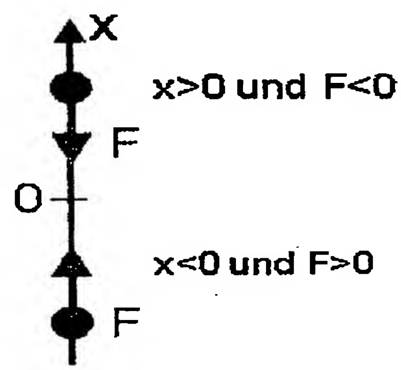
harmonische Schwingung ⇄ **lineares Kraftgesetz**

Rücktreibende Kraft - Richtgröße - Schwingungsdauer

Wendet man auf die obige Zeit-Beschleunigungs-Beziehung das Gesetz von Newton II ($F = m \cdot a$) an und berücksichtigt man noch die Zeit-Orts-Beziehung, so ergibt sich:

$$F(t) = -m \cdot \omega^2 \cdot x(t)$$

- Aus dieser Beziehung ist die Proportionalität zwischen der Kraft und der Auslenkung abzulesen (lineares Kraftgesetz). Die Proportionalitätskonstant $C = m \cdot \omega^2$ wird als ***Richtgröße*** bezeichnet.
- Außerdem sieht man aus dieser Beziehung, dass die Kraft stets das entgegengesetzte Vorzeichen der Auslenkung besitzt. Ist z.B. x positiv, so ist die Kraft negativ, d. h. sie zeigt in die negative x-Richtung. Die Kraft ist also stets zum Nullpunkt der Schwingung hingerichtet. Man bezeichnet sie daher auch als ***rücktreibende Kraft***.



- ***Schwingungsdauer des Federpendels***
  Beim Federpendel ist die Richtgröße C gleich der Federhärte D (Gesetz von Hooke). Es gilt also:

$$D = m \cdot \omega^2 \Rightarrow D = m \cdot \left(\frac{2 \cdot \pi}{T}\right) \Rightarrow T = 2 \cdot \pi \sqrt{\frac{m}{D}}$$

  Die Schwingungsdauer des Federpendels ist unabhängig von der Auslenkung des Pendels.

- ***Schwingungdauer des Fadenpendels***

$$T = 2 \cdot \pi \sqrt{\frac{l}{g}}$$

Diese Formel gilt nur für kleine Pendelauslenkungen. Unter dieser Einschränkung ist T unabhängig von der Auslenkung (wenn sie nur klein genug ist) und auch unabhängig von der Pendelmasse. Die Größe g ist der Ortsfaktor.

Energiebetrachtung bei der Schwingung

Bei der mechanischen Schwingung ist ein periodisches Hin- und Herpendeln zwischen den zwei Energieformen "kinetische Energie" und "potentielle Energie" zu beobachten. Speziell beim Federpendel gilt:

$$E_{ges} = E_{pot} + E_{kin} \quad \Rightarrow \quad E_{ges} = \frac{1}{2} \cdot m \cdot v(t)^2 + \frac{1}{2} \cdot D \cdot x(t)^2$$

$$E_{ges} = \frac{1}{2} \cdot m \cdot [\hat{x} \cdot \omega \cdot \cos(\omega \cdot t + \varphi)]^2 + \frac{1}{2} \cdot D \cdot [\hat{x} \cdot \sin(\omega \cdot t + \varphi)]^2$$

$$\text{mit} \quad D = m \cdot \omega^2 \text{ ergibt sich:}$$

$$E_{ges} = \frac{1}{2} \cdot m \cdot \hat{x}^2 \cdot \omega^2 = \text{const da} [\cos(\omega \cdot t + \varphi)]^2 + [\sin(\omega \cdot t + \varphi)]^2 = 1 \text{ ist.}$$

Die Gesamtenergie der Schwingung ist also zeitlich konstant.

Hinweis:

Das periodische Hin- und Herpendeln zwischen zwei Energieformen ist ein allgemeines Kennzeichen einer Schwingung. So tritt z.B. bei den elektromagnetischen Schwingungen ein Hin- und Herpendeln zwischen "elektrischer Energie" und "magnetischer Energie" auf.

Die Grundlagen der harmonischen Schwingung eines Federpendels werden sehr eindrucksvoll in dem Applet von W. Fendt zusammengestellt.

Zurück zur Materialseite

Vergleich zwischen mechanischer und elektromagnetischer Schwingung

Freie ungedämpfte Schwingung:

Mechanische Federschwingung	Ungedämpfter Schwingkreis
Äußere Kraft = 0	Äußere Spannung = 0
Reibungskraft = 0	Ohmscher Widerstand = 0
$F = F_{Träge} + F_{Feder} = 0$	$U = U_L + U_C = 0$
$ma + Dx = 0$	$L\dot{I} + \frac{1}{C}Q = 0$
$m\ddot{x} + Dx = 0$	$L\ddot{Q} + \frac{1}{C}Q = 0$
$\ddot{x} + \frac{D}{m}x = 0$	$\ddot{Q} + \frac{1}{LC}Q = 0$
mit $\omega = \sqrt{\frac{D}{m}}$ folgt $\ddot{x} + \omega^2 x = 0$	mit $\omega = \frac{1}{\sqrt{LC}}$ folgt $\ddot{Q} + \omega^2 Q = 0$
$x(t) = x_0 \cdot \cos\omega t$	$Q(t) = Q_0 \cdot \cos\omega t$

Freie gedämpfte Schwingung:

Mechanische Federschwingung	Gedämpfter Schwingkreis
Äußere Kraft = 0	Äußere Spannung = 0
Reibungskraft $F_R = k \cdot v \neq 0$	Ohmscher Widerstand $R \neq 0$
$F = F_{Träge} + F_R + F_{Feder} = 0$	$U = U_L + U_R + U_C = 0$
$ma + kv + Dx = 0$	$L\dot{I} + RI + \frac{1}{C}Q = 0$
$m\ddot{x} + k\dot{x} + Dx = 0$	$L\ddot{Q} + R\dot{Q} + \frac{1}{C}Q = 0$

Oszillation: $\frac{k^2}{4m^2} < \frac{D}{m}$	Oszillation: $\frac{R^2}{4L^2} < \frac{1}{LC}$
$x(t) = x_0 \cdot e^{-\frac{k}{2m}t} \cdot \cos\omega t$ mit $\omega = \sqrt{\frac{D}{m} - \frac{k^2}{4m^2}}$	$Q(t) = Q_0 \cdot e^{-\frac{R}{2L}t} \cdot \cos\omega t$ mit $\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$
aperiodischer Grenzfall: $\frac{k^2}{4m^2} = \frac{D}{m}$	aperiodischer Grenzfall: $\frac{R^2}{4L^2} = \frac{1}{LC}$
$x(t) = x_0 \cdot e^{-\frac{k}{2m}t}$	$Q(t) = Q_0 \cdot e^{-\frac{R}{2L}t}$
Kriechfall: $\frac{k^2}{4m^2} > \frac{D}{m}$	Kriechfall: $\frac{R^2}{4L^2} > \frac{1}{LC}$

LK Ph 12 — Fachbereich Physik — Fachbereiche

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Suchbegriff (Englisch oder Deutsch):
schwingung

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Benutzungshinweise

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Optionen
(Voreinstellungen fett)

Übersetzungsrichtung:	
○ Englisch -> Deutsch	
◉ **Deutsch <-> Englisch**	
○ Deutsch -> Englisch	
Ergebnisverlinkung:	
○ Nein	◉ **Ja**
Abweichungstoleranz:	
○ Nie	○ Immer
◉ **Standard**	
Überschriften:	
○ Nein	◉ **Ja**
Resultatanzeige:	
◉ **Mit Gitter**	○ Ohne
Notationstoleranz:	
○ Groß	○ Strikt
◉ **Standard**	
Sprachversion:	
◉ Deutsch	○ Englisch

13 Treffer für 'schwingung'

ENGLISCH	DEUTSCH	
Unmittelbare Treffer		
oscillation [tech.]	die **Schwingung**	g d P
stress [tech.]	die **Schwingung**	g d P
vacillation	die **Schwingung**	g d P
vibrancy	die **Schwingung**	g d P
vibration [engin.] [phys.]	die **Schwingung**	g d P
vibration [tech.]	die **Schwingung**	g d P
Zusammengesetzte Einträge		
oscillation ringing [tech.]	abklingende **Schwingung**	P
electric oscillation [elec.]	elektrische **Schwingung**	P
damped oscillation [tech.]	gedämpfte **Schwingung**	P
harmonic	harmonische **Schwingung**	P
harmonic oscillation [tech.]	harmonische **Schwingung**	P
self-induced vibration [tech.]	selbsterregte **Schwingung** *[Turbinen & Generatoren]*	P
stress due to vibration and shock [tech.]	Beanspruchung durch **Schwingung** und Stoß	P

Legende
- d: Definition, deutsch 4)
- e: Zusatzinformation für 'Phrasal Verbs', englisch 1)
- f: Forums-Diskussionen
- g: Grammatik, deutsch 3)
- m: Aussprache und Definition, englisch 2)
- o: Orthographie, deutsch 3)
- P: Aussprache, deutsch 5)
- v: Variante, deutsch und englisch

1): Basierend auf Englishpage.com
2): Basierend auf Merriam-Webster's Collegiate(R) Dictionary.
3): Basierend auf Canoo.com und WMTrans
4): Basierend auf DWDS, Wörterbuch der Gegenwartssprache
5): Basierend auf PROSER/ATIP und MBROLA

Mathematik-Online-Lexikon: Erläuterung zu

Überlagerung harmonischer Schwingungen gleicher Frequenz

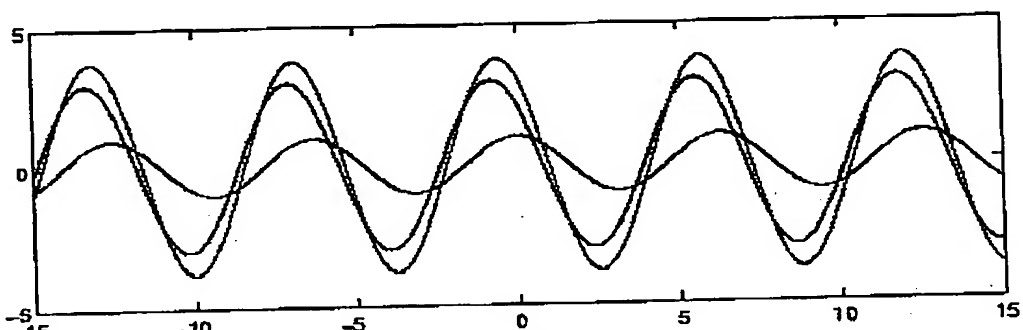
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Übersicht

Die Überlagerung zweier harmonischer Schwingungen

$$c_k \cos(\omega t - \delta_k), \quad k = 1, 2,$$

ist harmonisch mit Amplitude

$$c = \sqrt{c_1^2 + 2\cos(\delta_1 - \delta_2)c_1 c_3 + c_2^2}\,.$$



$\cos t + 3\cos(t + \frac{\pi}{4})$

Aus der komplexen Form der Überlagerung

$$\mathrm{Re}\,(c_1 \exp(\mathrm{i}\omega t - \delta_1) + c_2 \exp(\mathrm{i}\omega t - \delta_2)) = \mathrm{Re}\,([c_1 e^{-\mathrm{i}\delta_1} + c_2 e^{-\mathrm{i}\delta_2}]e^{\mathrm{i}\omega t})$$

folgt

$$[\ldots] = c\exp(-\mathrm{i}\delta) = z$$

und damit

$$c^2 = z\bar{z} = (c_1 e^{-\mathrm{i}\delta_1} + c_2 e^{-\mathrm{i}\delta_2})(c_1 e^{\mathrm{i}\delta_1} + c_2 e^{\mathrm{i}\delta_2})\,.$$

Ausmultiplizieren unter Berücksichtigung von $e^{\mathrm{i}s} + e^{-\mathrm{i}s} = 2\cos s$ ergibt die Behauptung.

Alternativ läßt sich die Amplitude auch aus der Darstellung

$$x_k(t) = a_k \cos(\omega t) + b_k \sin(\omega t)$$

berechnen. Man erhält dann

$$c = \sqrt{(a_1 + a_2)^2 + (b_1 + b_2)^2}\,.$$

(Autoren: Höllig/Kopf)

[Zurück zur Aussage]

automatisch erstellt am 3. 1. 2004

Mathematik-Online-Lexikon: Erläuterung zu

Modulierte Schwingung

Die Überlagerung zweier Schwingungen $c_k e^{i\omega_k t}$ läßt sich als Produkt

$$c(t)e^{i\bar{\omega}t}, \quad c(t) = c_1 e^{-i\Delta\omega t} + c_2 e^{i\Delta\omega t},$$

schreiben mit $\bar{\omega} = (\omega_1 + \omega_2)/2$ und $\Delta\omega = (\omega_1 - \omega_2)/2$. Diese resultierende Schwingung ist nur dann periodisch, wenn das Frequenzverhältnis ω_1/ω_2 rational ist.

Der Betrag der modulierten komplexen Amplitude schwankt zwischen dem minimalen und maximalen Wert $|c_1 - c_2|$ bzw. $c_1 + c_2$. Insbesondere ist

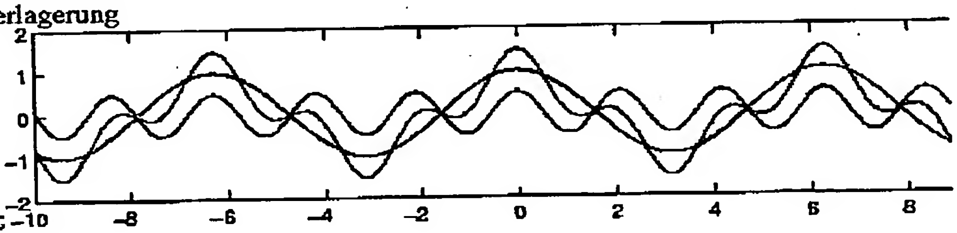
$$c(t) = 2c\cos(\Delta\omega t)$$

für gleiche Amplituden $c = c_1 = c_2$.

Die folgenden Abbildungen zeigen einige typische Fälle.

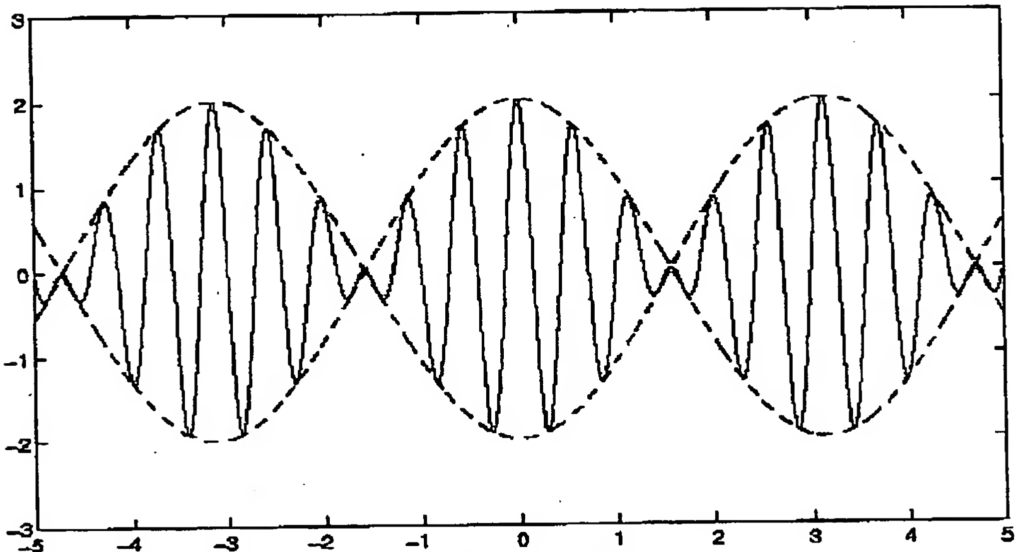
- periodische Überlagerung

heightheight



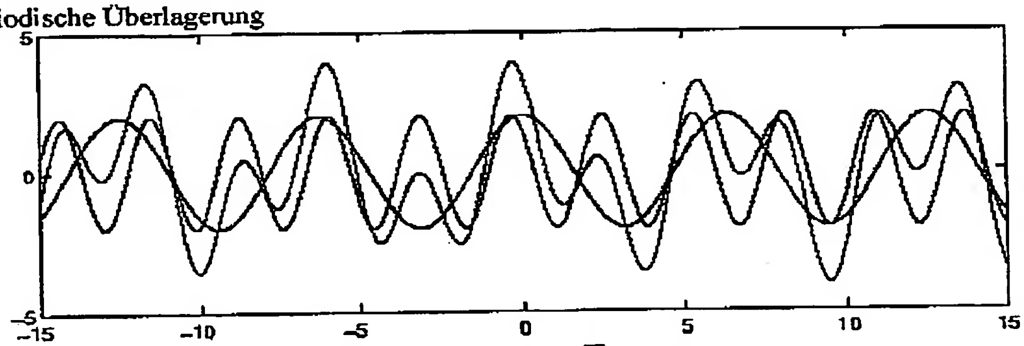
$$\cos t + \tfrac{1}{2}\cos 3t$$

- gleiche Amplituden und $\omega_1 \approx \omega_2$



$\cos 10t + \cos 12t$

- aperiodische Überlagerung



$2\cos t + 2\cos(\sqrt{5}t + \frac{\pi}{4})$

(Autoren: Höllig/Kopf)

[Zurück zur Aussage]

automatisch erstellt am 3. 1. 2004

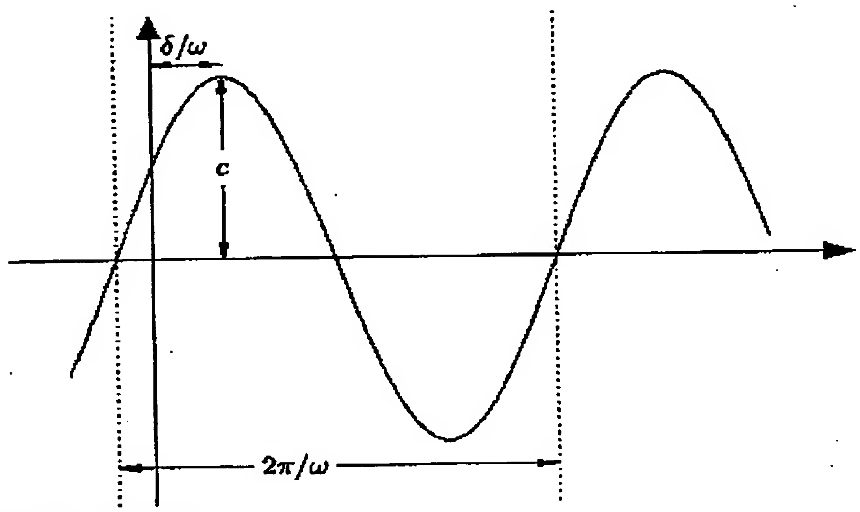
Mathematik-Online-Lexikon:

Harmonische Schwingung

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Übersicht

Eine harmonische Schwingung mit Amplitude $c \neq 0$, Frequenz ω und Phasenverschiebung δ hat die Form

$$x(t) = c\cos(\omega t - \delta) .$$



Äquivalente Darstellungen sind

$$\operatorname{Re} c \exp(\mathrm{i}(\omega t - \delta))$$

oder

$$a\cos(\omega t) + b\sin(\omega t) .$$

(Autoren: Höllig/Kopf)

Erläuterung:

- Umrechnung der Parameter

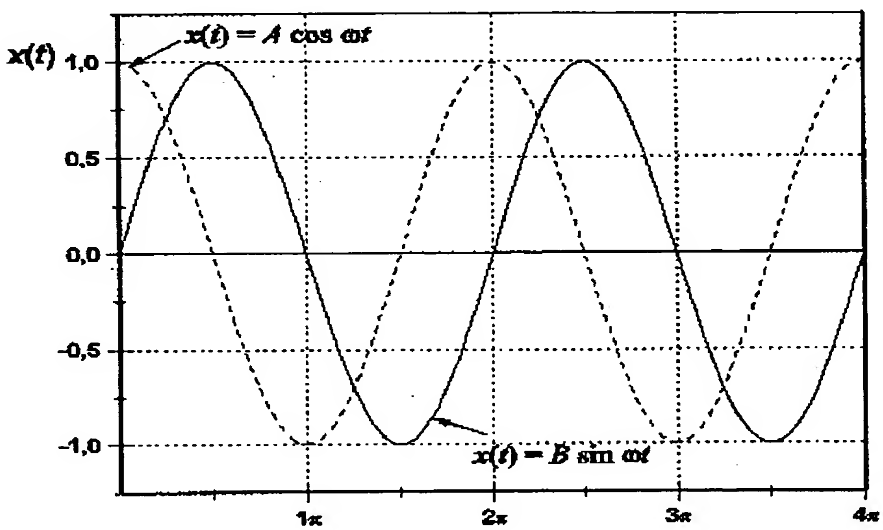
[Verweise]

harmonische Schwingung Kinematik - Technische Mechanik III

Ändert sich die Zustandsgröße $x(t)$ eines periodischen Vorgangs kosinus- oder sinusförmig nach dem Gesetz

$$x(t) = A\cos\omega t \qquad \text{bzw.} \qquad x(t) = B\sin\omega t$$

spricht man von harmonische Schwingung. Das unten stehende Bild zeigt die Auftragung der beiden Funktionen der harmonischen Schwingung ohne Dämpfung mit den beiden Amplituden $A = 1$ und $B = 1$.



Dabei ist ω [1/s] die Kreisfrequenz gegeben durch

$$\omega = 2\pi f = \frac{2\pi}{T}$$

mit der Periode T [s] und der Frequenz f [Hz] der harmonischen Schwingung.
Allgemein lassen sich reine Sinus- bzw. Kosinusschwingungen durch eine gemeinsame Funktion als Superposition beschreiben

$$x(t) = A\cos\omega t + B\sin\omega t\,.$$

Durch die Wahl einer gemeinsamen Amplitude C läßt sich diese Gleichung in folgende Form überführen

$$x(t) = C\cos(\omega t - \varphi_0)\,,$$

wobei die Amplitude C mit den Einzelamplituden

$$A = C\cos\varphi_0\,,$$

$$B = C \sin \varphi_0$$

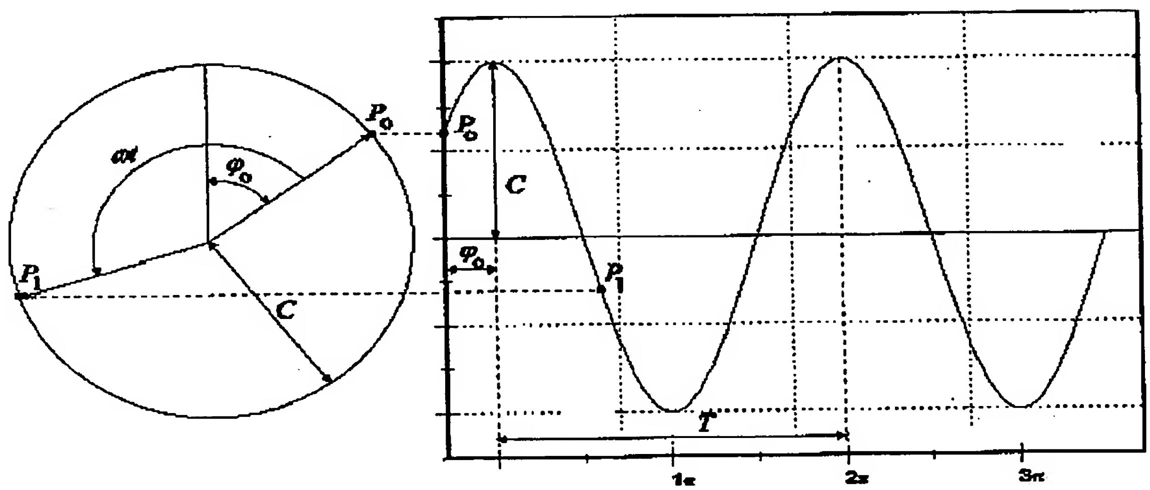
wie folgt gegeben ist

$$C = \sqrt{A^2 + B^2}.$$

Mit der Phasenverschiebung φ_0 [rad], die sich wie folgt bestimmt

$$\varphi_0 = \tan \frac{B}{A},$$

sind beliebige Anfangsbedingungen der harmonischen Schwingung beschreibbar. Das untere Bild zeigt, daß die harmonische Schwingung die Bewegung eines Punktes auf einer Kreisbahn mit konstanter Kreisfrequenz bzw. Winkelbeschwindigkeit ω projeziert. Die Projektion des Punktes P_0 auf die vertikale Achse zeigt im zeitlichen Verlauf die harmonische Schwingung.



Sind die Anfangsbedingungen der harmonischen Schwingung mit der Anfangsauslenkung x_0 und der Anfangsgeschwindigkeit v_0 gegeben

$$x(0) = x_0 \qquad \text{und} \qquad \dot{x}(0) = v_0$$

so können die Konstanten A, B, C und die Phasenverschiebung φ_0 wie folgt bestimmt werden

$$x(0) = A = x_0,$$

$$\dot{x}(0) = B\omega = v_0 \rightarrow B = \frac{v_0}{\omega},$$

$$C = \sqrt{x_0^2 + \left(\frac{v_0}{\omega}\right)^2},$$

$$\varphi_0 = \arctan \frac{v_0}{\omega x_0}.$$

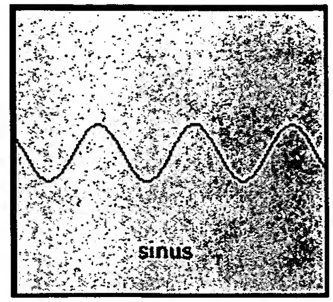
►►► Schwingung, freie Schwingung, gedämpfte Schwingung - Home

sine

trigonometric

last updated: 2003-12-09

$y = \sin x$



In the antiquity the sine was used as the length of a chord. Given a circle with a certain radius, for a large amount of values of the angles the lengths of chords were written down [1]. Such cord tables can be found in Ptolemy's' Almagest (150 AC) and in the Indian Surya Siddanta, and were used especially by astronomers.
In the late Middle Ages there was a short period that one used to write the tangent as sixtieths of the radius, and sixtieths of sixtieths. It was the German astronomer *Regiomontanus* (*Johannes Muller*, c. 1450), who prevented this practice. He wrote the trigonometric functions as lengths of chords for a circle with a radius of 10^n (n = 5 - 15), so that the results could be written as whole numbers.

It was not earlier than the 19th century that the sine got his actual meaning as the proportion of line segments. Geometrically the sine can be defined, in a rectangular triangle (Euler) as the proportion of the opposite side to the hypotenuse. Another way to define the curve is as a power series [2].
A sine curve is also called a **sinusoid**.

A point moves with constant speed on the circumference of a circle. Take as center of the circle the origin, then the coordinates of the moving point as function of the rolled angle a are: (cos(a), sin(a)). So the component along an arbitrary diameter is a sine function of time. This is the definition of a *harmonic oscillation*. Necessary for this movement is a force, which is proportional to the movement: $F = - k x$.
The sine obeys this rule, because for its second derivative applies: $y'' = - y$.

In fact, the harmonic oscillation is the form in which we meet the sine in our physical world.
A moving harmonic oscillation gives as result a sinusoid wave. The periodicity of the sine is called the *wavelength*, the amplitude is the factor of sin x.
Imagine a triangle, the *sine formula* states that the ratio of the sine of an angle and the opposite side is equal for all three angles.
An **equalized sine** is the result when the negative values have been turned: $y = |\sin x|$.

Sine means bend, curve, bosom. It is a literal translation of the Arab *gaib*, what has been derived from *gib*, a way to spell the Indian *jya* (cord). So there is a relation with the old habit of using the sine as the length of a cord. In natural life we see the sine form in the bosom of a wife.
In screwing activities we make a three dimensional **helical line**, when projecting the line on a surface through the screw's axis the result is again a sine.
In the bicycle-loving country of Holland, research led to the conclusion that a street threshold (to limit the speed of the cars) in the form of a sine is the most comfortable form for bicycling.

The **cosine** is defined - in the same rectangular triangle - as the proportion of the adjacent side to the hypotenuse.
The cosine is a translated sine: $\cos x = \sin (x + \Pi/2)$.
The cosine formula is an extension of the theorem of Pythagoras. For a triangle without a rectangular angle, it states that $a^2 = b^2 + c^2 - 2bc \cos \Phi$ [3].
Directly derived from the sine are the **versine** and the **haversine**. The versine is defined as vers(x) = 1 - cos(x); the haversine is defined as hav(x) = 1/2 vers(x).

The inverse functions of the sine and the cosine are called the **arc sine** arcsin(x) and the **arc cosine** arccos(x), respectively. These are cyclometric functions.

Sine series and *cosine series* are obtained while adding sines or cosines, in the sine summation.

---

notes

1) The length of a cord can be written in our current notation as: cord(a) = 2 R sin (a/2)

2) The sine as a power series:

$$\sin x = \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n+1}}{(2n+1)!}$$

3) The angle Φ is the angle opposite line a.

damped harmonic oscillation

exponential

last updated: 2003-07-19

Suppose a harmonic oscillation that is damped by a force, which is magnitude proportional to the velocity [1]. This is called a free damped harmonic oscillation. There are three possible situations, which are treated on this page.
The following curves give the amplitude as function of time.

strong damping

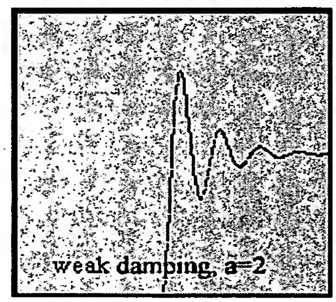
$$y = e^{-ax} \sinh x$$

The function is the product of an exponential function and a hyperbolic sine.

weak damping

$$y = e^{-ax} \sin x$$

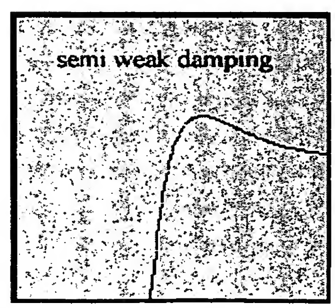
The function is the product of an exponential function and a sine.



semi weak damping

$$y = x \cdot e^{-x}$$

The function is the product of an exponential function and a line.



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notes

1) Differential equation: y" + a y' + b y = 0 with y(0) = 0.

Kuipers 1966 p.345.

SIMPLE HARMONIC MOTION (SHM)

Regular OSCILLATION, for instance, by a particle in a solid, fluid or gas, displaced from its normal position or random motion, when the force required is proportional to the displacement.

This motion may be approximated by that of the tines of a tuning fork when struck, and could be seen as a *sinusoidal* or SINE WAVE from the trace of a pen attached to the tine and moving against paper travelling at uniform speed. Similarly, simple harmonic motion may be derived from the projection onto the axis of a circle of a point moving with constant speed on the circumference, as shown in the diagram below.

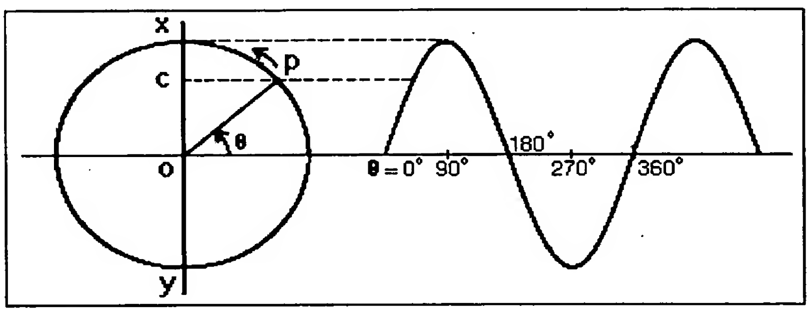
See: CYCLE, PARTICLE VELOCITY, PERIODIC, PHASE, SOUND PRESSURE, VIBRATION. Compare: FOURIER ANALYSIS.

The angular velocity ω of the motion is defined in radians per second as the angle θ moved through per unit time, and is related to the FREQUENCY f by the equation:

$$\omega = 2\pi f$$

The displacement *d,* whose maximum is the AMPLITUDE *A,* may be expressed as:

$$d = A \sin\theta = A \sin\omega t = A \sin(2\pi f t)$$



Geometric derivation of simple harmonic motion. A point *p* moves at constant speed on the circumference of a circle in counter-clockwise motion. Its projection OC on the vertical axis XOY is shown at right as a function of the angle *θ*. The function described is that of a sine wave.

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OSCILLATION

Any quantity or body is in a state of oscillation when its value or motion is continually changing so that it passes through maximum and minimum values or positions. When a system, body or quantity is set in PERIODIC motion or vibration, it is said to be in oscillation.

A swinging pendulum, a vibrating string, or a bobbing buoy are all examples of oscillation and SIMPLE HARMONIC MOTION. However, RANDOM NOISE is also an oscillation since it passes through maximum and minimum values.

An oscillation is said to be *forced* when it is in response to an excitation; otherwise it is called *free vibration* (see EIGENTON, RESONANCE, STANDING WAVES, SYMPATHETIC VIBRATION).

Oscillations whose FREQUENCY lies within the audible range are heard as SOUND. Compare: VIBRATION.

See also: AMPLITUDE, CYCLE, DECAY TIME, HARMONIC, PARTICLE VELOCITY, RISE TIME, SOUND PRESSURE, SOUND WAVE, TREMOLO, VIBRATO, WAVELENGTH, WOW. Compare: ALTERNATING CURRENT, OSCILLATOR.

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RANDOM NOISE

An OSCILLATION whose instantaneous magnitude is not specified for any given instant of time, but rather is described in terms of probability distribution functions such as the Gaussian. Also called GAUSSIAN NOISE.

Compare: BACKGROUND NOISE, RUSTLE NOISE , STOCHASTIC PROCESS, WHITE NOISE.

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